Computer Science

Cellular Approach to Computer Generated Holography

Douglas Harms(*), *Computer Science Depart, DePauw University, IN 46135(dharms@depauw.edu)*
Grace Nijm, *Computer Science Depart, Benedictine University, IL 60532; Computer Engineering Depart, Illinois Institute of Technology, IL, 60616(grace_nijm@ben.edu)*
Lane Herrington, *Mathematics Depart, Saint Mary's College, IN 46135(herr5709@saintmarys.edu)*

Holography is the process of recreating a virtual three-dimensional image in space. Traditionally, holograms are created by reflecting light waves off an object. The interference pattern produced by these waves is then recorded on photographic film. The process requires exact configurations for the laser, mirrors, film, and object to be recorded. This approach is limited in that it requires the physical presence of the object in question. Computer generated holography, however, avoids this constraint, requiring only a mathematical description of the object. In addition, it eliminates the need for a complex setup.

Computer generated holography uses an object's mathematical description, comprised of a set of points called source points, to calculate the interference pattern. We derived a set of equations that described how light would reflect off an object and used these values to determine the interference pattern. Our approach was to develop an algorithm utilizing cellular computers to create a hologram in real time.

We found the most efficient method to be the division of the hologram into blocks and then the subdivision of those blocks into cells that represent pixels. This division scheme proved to be most expedient as it allowed us to manipulate the smallest possible partition, a pixel. Each pixel has exactly one processor that will handle only the calculations required for that cell. These individual processors are networked, so information can be shared between them. In addition, the blocks themselves are networked in the same manner. The cell in the lower left corner of the lower left block computes a set of complex calculations. This information then travels up and to the right within the block and between blocks. Thus, the rest of the cells do not have to perform as many or as complex of calculations as the initial cell did. Rather, they utilize the information they have already received to calculate their own values using addition, subtraction, multiplication and division. As a result, the total number and complexity of calculations are reduced, and less time is required, as many cells are computing simultaneously.

Due to a lack of hardware, we developed a simulator that works as described above. To fully implement our cellular computing approach, each pixel would require its own processor, and those processors would need to be networked. Under such conditions, we believe that our method would enable holograms to be generated in real time.

Acknowledgment: This work was supported by NSF REU grant number EIA-9911626.